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EXAMINER

BERDICHEVSKY, MIRIAM

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

DETAILED ACTION

Remarks

Claim 1 is amended. Claims 1-9 and 11 are currently pending.

Status of Rejections

All rejections other the previous office action are withdrawn in view of Applicant's amendments. New ground of rejection is presented in view of Applicant's amendments.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

4. Claims 1-2, 5-7, 9 and 11 are rejected 35 U.S.C. 103(a) as being unpatentable over Ding (*"Nanofabrication of Organic/Inorganic Hybrids of TiO₂ with Substituted Phthalocyanine or Polythiophene"*) and Zhao (*Polymer brushes: surface immobilized macromolecules*).

As to claim 1, Ding teaches a method of preparing a pn—semiconductor material that can be obtained by the following steps: providing a substrate, a step in which a substrate made of porous oxide ceramic (porous TiO_2 nanoparticles – section I, ¶ 2) is functionalized by chemical grafting of one or more compounds containing at least one group (carboxylic groups, sulfonic acid groups- section I, ¶ 3) that can be polymerized with one of more precursors of an electrically conducting polymer (PTAA - section I, ¶ 3) and at least one group able to be chemically grafted (covalent linkage - section I, ¶ 3) onto said substrate; and a step in which the substrate thus functionalized is impregnated with a solution containing an electrically conducting polymer (section 3.1.2., ¶ 1). The Examiner notes that TiO_2 is the n-type material and the conducting polymer the p-type material. Ding is silent to a step in which the substrate thus functionalized being impregnated with a solution containing the precursor(s); and a step in which the precursor(s) are polymerized.

Zhao teaches a conventional chemical grafting method (grafting from) that requires the step of first providing a substrate, then functionalizing the surface (I, initiators) and finally impregnating with a solution of precursors (M, monomers) which are then polymerized (Figure 9). Zhao teaches that the advantage of using ‘grafting from’ rather than the method taught by Ding (grafting to) is that there is an increase in grafting density, as taught by Zhao (page 693 and 695, section 4). Zhao teaches that the methods of adsorption, grafting to and grafting from are well known and conventional methods of forming tethered/grafted polymers from substrates.

Taking the references as a whole, it would have been obvious to one of ordinary skill in the art at the time of the invention to use the 'grafting from' method of Zhao in Ding because 'grafting from' decreases the amount of steric hindrance because the precursor (monomers) are smaller molecules than polymers and can readily reach the substrate to link (Zhao: page 695) especially in light of the fact that Ding teaches that increased density of conducting polymer maximizes efficiency (section 1, ¶ 2).

Regarding claims 2 and 5, Ding teaches that the ceramic is TiO_2 (section 1, ¶ 2).

Regarding claim 6, Ding teaches that the group able to be chemically grafted onto the ceramic is COOR^1 where R^1 represents a hydrogen atom (carboxylic groups) or phthalocyanine tetrasulfonic acid tetrasodium salt $\text{SO}_3\text{M}'$ (section 1, ¶ 3).

Regarding claim 7, modified Ding teaches that the group chosen COOR^1 and $\text{SO}_3\text{M}'$ can be polymerized with precursors (Zhao: see claim 1) of an electrically conducting polymer chosen group thiophene (PTAA) (Ding: section 1, ¶ 3).

Regarding claim 9, modified Ding teaches that the porous oxide ceramic substrate is TiO_2 chemically grafted by thiophene-3-acetic acid (if the polymer directly bonds to the substrate then the link between the substrate and the polymer less one unit will be a monomer of the polymer which is thiophene-3-acetic acid) to an alkylthiophene (remainder of the PTAA) (Figure 1). Therefore, in the event of using 'graft from' the first linkage between a monomer and the porous oxide will provide the functionalization with the required formula followed by polymerization with the remainder of the monomers, alkylthiophenes to produce grafted PTAA.

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As discussed above in relation to claim 1, it would have been obvious to one of ordinary skill in the art to use “graft from” because ‘grafting from’ decreases the amount of steric hindrance because the precursor (monomers) are smaller molecules than polymers and can readily reach the substrate to link (Zhao).

Regarding claim 11, modified Ding teaches the use of the pn-semiconductor material comprising a porous metal oxide ceramic chemically grafted to an electrically conducting polymer grafted thereto for use in a solar cells (section 1, ¶ 1), but is silent to the pn-semiconductor material being between the electrodes.

It would have been obvious to one of ordinary skill in the art to at the time of the invention to place the pn-semiconductor material between a first and second electrode in the solar cell because otherwise the solar cell would not function.

5. Claims 3-4, 8 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ding and Zhao as applied to claim 1 above, and further in view of O’regan (*A low cost, high efficiency solar cell based on dye sensitized colloidal TiO₂ films*).

Regarding claim 3, modified Ding does not specify that the nanoparticles are mesoporous.

O’Regan teaches mesoporous (2-50nm) nanoparticles (page 738, ¶ 3).

It would have been obvious to one of ordinary skill in the art at the time of the invention to use the mesoporous nanoparticles of O’Regan in Ding because the optimum diameter value of pores that results from a compromise between increased surface area (more smaller pores) and large enough diameter to decrease steric hindrance effects during polymerization) is a result effective variable that involves only

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routine skill in the art especially in light of the fact that the porous oxide films of O'Regan display exceptionally high efficiencies (abstract).

Regarding claim 4, Ding teaches that the nanoparticles are mesostructured (network of porous nanoparticles) (section I, ¶ 2).

Regarding claim 8, Ding teaches that sensitization of the semiconductor with dye (chromophores) is well known in the art (section 1) and that the semiconductor of Ding can be sensitized with dye or conducting polymer but is silent to the sensitization of both dye and polymer at the same time.

It would have been obvious to one of ordinary skill in the art at the time of the invention to use both dye and polymer to sensitize the semiconductor because it has been held that combining two elements known useful for the same purpose to form a third used for the same purpose flows logically from their having been individually taught (MPEP 2144) especially in light the fact that the dye molecules give rise to electron injection into the semiconductor, as taught by O'Regan (page 737). Moreover, using both conducting polymer and dye would have produced the predictable result of added semiconductor coverage with electron injection molecules.

Regarding claim 11, modified Ding teaches the use of the pn-semiconductor material comprising a porous metal oxide ceramic chemically grafted to an electrically conducting polymer grafted thereto for use in a solar cells (section 1, ¶ 1), but is silent to the pn-semiconductor material being between the electrodes.

It would have been obvious to one of ordinary skill in the art to at the time of the invention to place the pn-semiconductor material between a first and second electrode in the solar cell because otherwise the solar cell would not function.

Response to Arguments

Applicant's arguments with respect to claims 1-9 and 11 have been considered but are not persuasive. In response to applicant's argument that Zhao is nonanalogous art, it has been held that a prior art reference must either be in the field of applicant's endeavor or, if not, then be reasonably pertinent to the particular problem with which the applicant was concerned, in order to be relied upon as a basis for rejection of the claimed invention. See *In re Oetiker*, 977 F.2d 1443, 24 USPQ2d 1443 (Fed. Cir. 1992). In this case, Ding is drawn to a solar cell wherein polymer is tethered from a substrate. Ding teaches that covalently (tethering) linking polymer to a substrate is more advantageous than the adsorption of the prior art (section 1). Zhao is a summary of the tethered polymer art such that one of ordinary skill in the art looking to solve the problem of how to tether polymers to a substrate would look to the tethered polymer art such as Zhao. Especially in light the fact that KSR has held that it would have been obvious to chose from finite possibilities with a reasonable expectation of success. Applicant argues that the combination of Ding and Zhao would yield unsatisfactory results because Ding states that "[it] is necessary for PTHs (conducting polymers) to be adsorbed onto the nanoparticle surface in a closely packed monolayer for maximum efficiency" and "it is important to design the PTHs-TiO₂ contact to improve light absorption, carrier generation and transport properties" such that if the precursors were

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polymerized on the nanoparticles the PTHs-TiO₂ would not contact. The Examiner respectfully disagrees and believes Applicant has misunderstood the rejection and the references. Ding teaches TiO₂ with conducting polymers (PTHs) grafted thereto. Zhao teaches that the method Zing is one of three methods of grafting polymers to a substrate such as TiO₂. Zhao teaches that the method of grafting from which reads on the instant claimed invention is advantageous over the method used in Ding by increasing the grafting density. Ding stating that it is necessary to attach conducting polymer in a closely packed monolayer strengthens the combination because Zhao achieves just that. The method of Zhao is advantageous to the method Ding because it enables for increasing grafting density by using monomers during the grafting process rather than the bulky polymers of Ding. Ding's statement that "it is important to design the PTHs-TiO₂ contact..." is again referring to the importance of creating contact between the conducting polymer and TiO₂. Both Ding and Zhao achieve this contact by grafting polymer to the substrate rather than relying on adsorption which is a less reliable contact than a robust covalent bond (section 1, ¶ 2 and Zhao: 4.1 ¶ 7 and section 4.2, ¶ 1). The Examiner is not persuaded that the combination of Ding and Zhao would destroy the intended purpose of Ding because Zhao merely provides a different method of making a similar end product of Ding.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP

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§ 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

Contact Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to **MIRIAM BERDICHEVSKY** whose telephone number is (571)270-5256. The examiner can normally be reached on M-Th, 10am-8pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Alexa Neckel can be reached on (571) 272-1446. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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/M. B./
Examiner, Art Unit 1795

/Alexa D. Neckel/
Supervisory Patent Examiner, Art Unit 1795